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ABSTRACT

Described is a highly individualized and open teaching situation, Student-Structured Learning in Biology (SSLB), used with a randomly selected group of 9th-, 10th-, and 11th-grade students at the Florida State University Developmental Research School. Students chose their own content and method of learning and were free to pursue, or not pursue, this learning whenever and wherever they decided. Students were required to keep daily logs and to submit both written and oral justifications of their self-assigned grades at the end of three-week intervals. Teachers did present activities, audiovisual aids, and other materials but students were free to choose or ignore them. A control class which was individualized to some extent and which made heavy use of modules and audiovisual aids was used for comparison. Students had also been randomly assigned to this class, referred to as Teacher-Structured Learning in Biology (TSLB). Analysis of figural creativity data revealed a significant (.05) difference between SSLB and TSLB students, favoring the SSLB group. There were no detectable differences for verbal creativity scores. The researchers considered their major successes to be in the affective areas (although these were poorly measured), citing student attitude changes and increased proficiency in identifying problem areas to pursue. (Authors/PEB)

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STUDENT STRUCTURED LEARNING IN BIOLOGY

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by

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INTRODUCTION

During the 1972-73 school year the authors set out to assess how a randomly selected group of 9th, 10th, and 11th grade students at the Florida State University Developmental Research School would react to a Biology class which was both highly individualized and open. This class was individualized in that the students could choose their own content and method of learning and open to the extent that students were free to pursue or not pursue this learning whenever and wherever they desired. We refer to this class as student structured learning in biology (SSLB).

Our goals in providing an SSLB environment were to 1) involve students in creatively identifying and attempting to solve science problems of interest to them, 2) help students become independent learners and thinkers, 3) help students improve their self-concept in regard to science and 4) help students accept other individuals with their different interests, opinions, and values.

The Class

With our goals in mind the SSLB class year was begun by telling the class that during the year they would be presented with a wide variety of activities, films, and written and manipulative materials with which to work. They were further told that they could choose to pursue these activities, other activities of their own choosing, or no activities in biology. Any restrictions were minimal and related to the safety and mechanical aspects of the classroom.

SE 017 954

The weekly logs were employed and designed to help the students assess their own progress and provided both student and teacher with tangible evidence concerning that progress. Daily individualized interaction between each student and one or more of the instructors also provided evidence of student progress. In addition to the logs, students were required to submit written as well as verbal justifications for their self-assigned grades at the end of each three-week interval. Thus, continous self-evaluation and grade assignments by students were integral dimensions of the SSLB class.

Introduced Activities

The initial activity, SOILS, was presented to the whole class in September. Later activities were presented to the whole class or to only a few students at a time as their interests dictated. All students were, however, free to stop what they were doing and begin a new activity at any time. SOILS, as were all the activities, was a minipulative activity designed to contain a number of inherrent problems, both concrete and abstract, that would intrigue students of different interests and abilities. Written suggestions were provided for all students but they were free to use those or ignore them.

Basically, the students were provided with a series of soil samples representing many geographical areas, equipment to test the physical and chemical nature of the soils, seeds, and a variety of references. Where appropriate, such as with the soil test chemicals, technique sheets describing basic skills were provided. Students were free to use or not use the technique sheets as they tested the soils. Several students were able profitably to continue using these same basic soil materials until June, while other students were unable to identify problems of their own or were not interested in pursuing suggested activities.

After offering these students numerous suggestions and having them rejected or ignored we introduced a new activity entitled SMALL THINGS. This unit dealt with micro-organisms, many of which live in the soil. As with all the activity units, SMALL THINGS contained suggested activities, technique sheets for skills such as making media and sterile procedures, and a variety of films and references.

Other activities presented during the school year included similar units on ANIMAL BEHAVIOR, FOOD CHEMISTRY, PLANT HORMONES, GENETICS, and PHYSIOLOGY. Each of these activities was presented in the same fashion as SOILS and SMALL THINGS.

In addition to the written and special materials for each activity the students had free access to all the chemicals, glassware, and equipment normally associated with a biology classroom. Giving the students the responsibility of material handling was designed to foster student independence and creativity as well as freeing the instructor to interact with other students.

Role of The Teacher

Our role as teachers was to encourage and facilitate student learning. However, content and mode of learning were student decisions. We spent our class-time observing students, accepting their intellectual behavior without evaluation, questioning individuals, responding, and occasionally, giving information. On no occasion, however, did we tell students what activity to do or how to do it, evaluate students on their behavior, or reject what the students were doing.

Typically, two of us were observing while the other two interacted with students. This eliminated the problem of "interacting with teachers" becoming a student activity and gave us some data on student behaviors as well as our own actions in the classroom.

The Control Class

To provide some comparison we chose as a control another biology class at the F.S.U. Developmental Research School. This class was also individualized to some extent and depended heavily on modules and audio-visual aids. During the school year this class covered such units as Asking Questions, The Cell, Reproduction and Development, Genetics, Evolution, and Nature Study.

The teacher's role in this class was to make assignments, interact with students working on assignments, and to evaluate student performance and achievement. Thus, we referred to this control class as being teacher-structured learning in biology (TSLB).

No attempt, other than random assignement of students to classes, was made to match student variables or topics in the experimental and control classes. These limitations must be considered when interpreting the results of the data analysis.

OBJECTIVE DATA COLLECTION AND ANALYSIS

To evaluate our success in achieving our goals we employed several techniques. These included pre and posttest administration of The Torrance Tests of Creative Thinking (TTCT) (figural and verbal, Torrance, 1966), student interviews, and non-intervention observation of student behaviors. Only the Torrance Tests are considered as formal, objective data. All other data were either collected in a non-systematic way or only during a few intervals of the study, and will not be discussed in this paper.

To provide two composite scores on the Torrance Tests, one figural and one verbal, a mean of all the T-scores for fluency, flexibility, and, in the case of the figural test, elaboration were calculated. Torrance (1966) has indicated that such composite scores provide a relatively stable index of the total amount of

creative energy a person is using or has available. These composite scores also tend to have reliabilities that are generally higher than for individual subscores. Torrance attributes this to fluctuations in the amount of creative energy a person may put forth on a given subsection of the tests. Also, since various researchers (Torrance, 1966; Yamamoto, 1965) have demonstrated an I.Q. threshold of 110 to 120 for creativity, student scores were blocked as representing students with high, medium, and low [1] aptitude scores on the Florida Ninth-Grade Test.

The composite pretest score for each of the Torrance Tests provided a covariate while each composite posttest score was used as the dependent variable to test the following null hypotheses:

Hypotheses 1. There is no difference in the mean posttest scores on the Torrance Test of Creative Thinking (figural) between students in the SSLB class and the TSLB class.

Hypothesis 2. The interaction effect of teaching pattern and student aptitude on figural creativity scores is zero.

Hypothesis 3. There is no difference in the mean posttest scores on the Torrance Test of Creative Thinking (verbal) between students in the SSLB class and the TSLB class.

Hypothesis 4. The interaction effect of teaching pattern and student aptitude on verbal creativity scores is zero.

RESULTS

Data for all four hypotheses were analyzed on a CDC 6500 computer with the General Linear Hypothesis Program (BMD05V) (1970). The hypotheses were tested at the 0.05 level of significance.

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[1] High = 80-100% ile

Medium = 50-79 % ile

Low = 0-49 % ile

The analysis of covariance results for figural creativity scores provided a treatment F-ratio of sufficient size to allow rejection of hypothesis 1 and an F-ratio large enough to indicate an effect of student aptitude on figural creativity scores. No rejection was the decision on Hypothesis 2.

Analysis of the verbal creativity scores revealed no treatment effect and the decision was made not to reject Hypotheses 3 and 4.

DISCUSSION OF OBJECTIVE DATA

Figural Creativity

Analysis of the figural creativity data revealed a significant (at $\alpha = 0.05$) difference between the SSLB and TSLB classes and allowed rejection of Hypothesis 1. This rejection can possibly be explained by further examining the nature of the biology instruction in the two classes.

(Insert table 1 and figure 1 about here)

In the SSLB class the students selected their own activity and materials and were encouraged to mainpulate and explain in whatever way they wished both their actions on the materials and the results of these actions. Such unrestricted activity could maximize the possibility of the students viewing their work in a number of ways while giving them the opportunity to do creative things with these materials.

The TSLB class, on the other hand, was told what activity to do and how to do it. The results were then evaluated by the teacher in accordance with the original instructions. Student grades depended on the number of units completed at a criterion level. Thus, students were encouraged to move through as many units as possible. Under these circumstances it is conceivable that TSLB students would not create as many different patterns or problems and might not think about what they are doing in as creative a way since they need only meet the criterion and then

move on. In general, the TSLB students may have had less opportunity to do creative work than SSLB students if only because the teacher controlled what was done with the materials and immediately issued new instructions as soon as a unit was successfully completed.

Student aptitude did appear as a factor with those students whose aptitude scores were below the 50th percentile scoring significantly (at the $\alpha = 0.05$ level) lower on the figural TTCT.

The significant difference in figural creativity composite scores and the lack of detectable difference in verbal composite scores substantiates a prior similar study (Penick, 1963) with fifth grade science students which produced essentially the same results.

Verbal Creativity

Analysis of the verbal creativity scores did not detect any differences between the SSLB and TSLB classes. This failure to reject may have been caused by several factors. Failure to reject might be explained by the emphasis of the verbal TTCT on writing questions, quesses, consequences, and other responses while neither biology class centered on writing. Both classes did use written materials however, with more reading being required and done in the TSLB class.

A second factor might be a writing ability threshold for the verbal TTCT. It is possible that all of the students in both classes exceeded this hypothetical threshold and, thus, achieved adequate scores on the test. However, no evidence is available to support this contention.

No I.Q. aptitude threshold for verbal creativity was demonstrated in this study.

(Insert Table 2 and Figure 2 about here)

The formal data from this rather limited study indicate that a non-directive,

student structured biology class can be developed with no loss or gain in student verbal creativity while students are able to make significant gains in figural creativity.

While the small sample size makes interpretation of the failures to reject difficult and provide few assurances as to the generalizability or replicability of these findings, the evidence or lack of evidence provided by this study indicates that teaching in a non-directive, open manner can work and deserves further well-controlled research.

OUR FEELINGS ABOUT THE CLASS

Like many teachers and researchers, we feel that our most important gains were those in poorly measured areas. Specifically, we consider our major successes to be in the affective areas. Student attitudes toward their own responsibility for learning in the classroom seemed to improve during the year. In many instances students became much more proficient at identifying problem areas to pursue.

During the school year we noticed a consistent trend of increasing student honesty--an honesty which did not prevail during the early weeks or months of the biology class. This honesty pervaded students-student and student-teacher interactions as well as student self-evaluation. In general, students became much more open in their feelings and expressions. Some of this openness, such as when individual students elected not to pursue biology activities, was occasionally bothersome to us. In fact, throughout the year, one of the most frustrating experiences for instructors, as well as students, was trying to help students become involved in meaningful activities of their choice. Frequently during the year students displayed an attitude of apathy, or occasionally, hostility toward being involved in science activities of any type. If one considers biology to be

a form of posttest for three or more years of science, such attitudes toward learning in general, and science in particular, should certainly be an area of concern. Our experiences during this year of student structured learning in biology have reaffirmed our initial conviction that a student structured approach to biology, while frustrating and difficult to implement, is very much needed.

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TABLE I

SUMMARY OF FIGURAL CREATIVITY SCORE ANALYSIS BLOCKED BY STUDENT ATTITUDE

Source	df	SS	MS	F-ratio
Treatment	1	2599.46	2599.46	8.73 *
Aptitude	2	3868.53	1934.27	6.50 *
Interaction	2	116.49	58.25	0.20
Error	40	11904.52	297.61	

* Value listed is significant at the $\alpha = 0.05$ level.

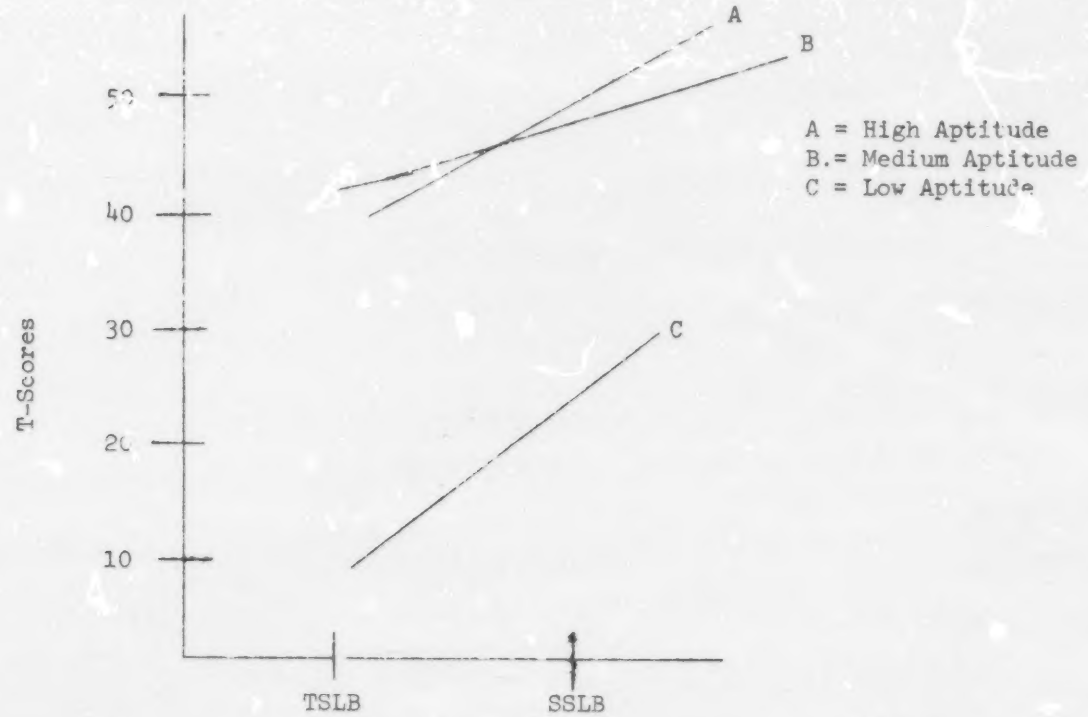

Figure 1. -- Graph of the Mean Figural Creativity Scores blocked by Student Aptitude

TABLE 2

SUMMARY OF VERBAL CREATIVITY SCORE ANALYSIS BLOCKED BY STUDENT APTITUDE

Source	df	SS	MS	F-ratio
Treatment	1	52.26	52.26	0.17
Aptitude	2	380.60	190.30	0.63
Interaction	2	477.74	238.87	0.79
Error	40	12044.78	301.12	

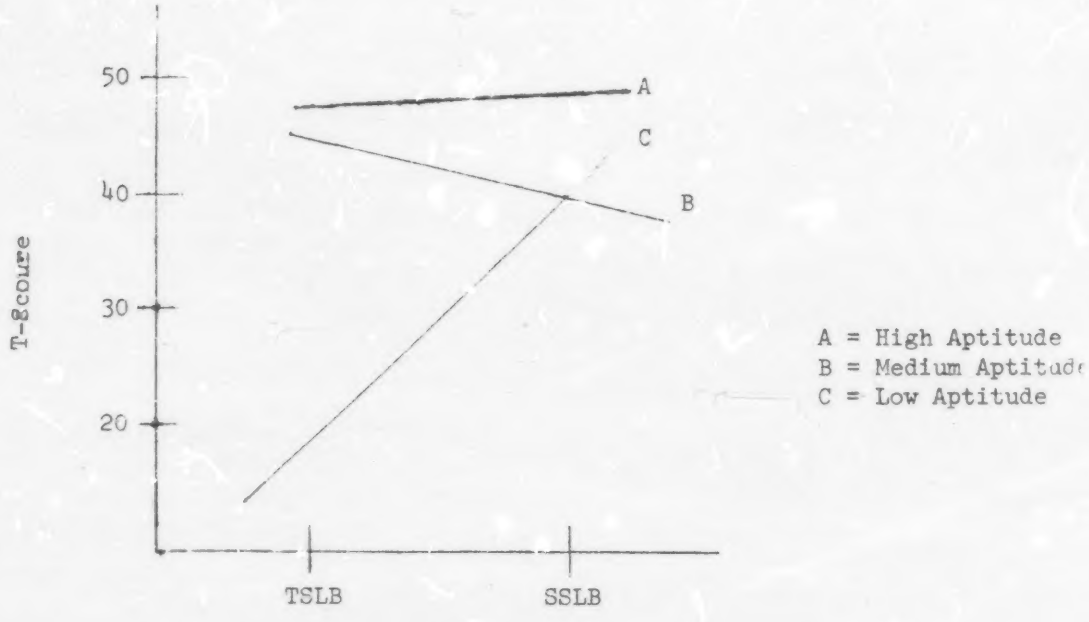

Figure 2. -- Graph of the Mean Vertal Creativity Scores blocked by Student Aptitude